San Jose State University
Department of Mechanical Engineering

ME 160 Introduction to Finite Element Method

Instructor:
Tai-Ran Hsu, Professor
Room 117B, Engineering Building
E-mail: tai-ran.hsu@sjsu.edu

Office hour: Thursdays 01:30 – 4:00 PM, or by appointment

Principal References**:
Other Recommended References:


** The instructor will post his slides used in the class instructions on his SJSU webpage for his students in the ME 160 class.
Grading Scheme:

Homework: 20%
Midterm exam: 20% (Monday, April 4, 2016) Room 213
Term Project: 25% (with team of approximately 3 students)
   Projects are on application of FEM using commercial FE code-ANSYS code on practical engineering problems
Final examination 35% (Tuesday, May 24, 2016, 9:45AM-12:00 noon, Room E213)

Letter grades will be assigned for the course according to the following scheme:

<table>
<thead>
<tr>
<th>Mark Range (%)</th>
<th>Assigned Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>95-100</td>
<td>A+</td>
</tr>
<tr>
<td>90-94</td>
<td>A</td>
</tr>
<tr>
<td>85-89</td>
<td>A-</td>
</tr>
<tr>
<td>80-84</td>
<td>B+</td>
</tr>
<tr>
<td>70-79</td>
<td>B</td>
</tr>
<tr>
<td>65-69</td>
<td>B-</td>
</tr>
<tr>
<td>60-64</td>
<td>C+</td>
</tr>
<tr>
<td>50-59</td>
<td>C</td>
</tr>
<tr>
<td>40-49</td>
<td>C-</td>
</tr>
<tr>
<td>30-39</td>
<td>D</td>
</tr>
<tr>
<td>Below 30</td>
<td>F</td>
</tr>
</tbody>
</table>

Both mid-term and final examinations will be of the format of “open books.” Students may bring to the exams any written materials and references as they wish.
NOTE:

(1) There will be **NO** make-up mid-term or final examination for students in this class, except for individuals with serious medical reasons such as immobility, high fever, etc. A medical doctor’s certificate is required to support such request. Requests for rescheduling mid-term or final examination with supporting documents must be submitted to the instructor 48 hours prior to or one day after the originally scheduled mid-term or final examination.

(2) Calculators and written materials are allowed in mid-term and final examinations. Students are not allowed to share these devices and written materials with others in mid-term and final examinations.

(3) *Late submission of homework past the due time and dates WILL NOT be accepted.*

(4) Students are encouraged form their own “study groups” and ask questions at all times in the classroom and during the office hours. Special arrangements can also be made for consultations and advice with the instructor.
Course Description

Introduction to finite element methods, **matrix algebra**, and interpolation functions. Deformation and stress analysis, using truss, beam, plate, and axisymmetric elements.

Course Goals

To learn the basic principles of finite element method with modeling and analyses of mechanical engineering problems.

To learn how to apply finite element solution to problems in mechanical engineering.

To learn how to use commercially available FE code, such as the ANSYS code to solve mechanical engineering problems.
**Student Learning Objectives**

By the end of the course, each student should be able to:

- Describe the discretization principle in the finite element analysis (FEA) and the procedure of the analysis
- Develop finite element equations for heat conduction in axisymmetric solid elements
- Develop stiffness equations for spring, beam, and 2-D solid elements
- Assemble element stiffness equations to a global equations for overall structures
- Identify and apply boundary conditions to a global structural matrix and reduce it to a solvable form
- Identify the application and characteristics of spring, beam, 2-D solid and 3-D solid elements
- The application of commercial finite element code, the ANSYS code for heat conduction and stress analysis of solids of complex geometry subject to complex boundary and loading conditions.
Course Outline:

Chapter 1 Fundamentals of Finite Element Method

Chapter 2 Finite Element Formulation by Variational Principle

Chapter 3 Steps in Finite Element Analysis

*Guest Lectures No. 1: Introduction of ANSYS Code (at about late February 2016)

Chapter 4 Finite Element Analysis in Stress Analysis of Solid Structures

Chapter 5 Finite Element Analysis of Heat Conduction

Chapter 6 Finite element Formulation of Thermoelastic Stress Analysis

*Guest Lectures No. 2: Case Simulations by ANSYS Code (at about mid-April 2016)

* Guest lectures will be offered by experts from the ANSYS, Inc. in San Jose. These lectures may be conducted in the forms of in-person lectures, or in “online classes.” They may be offered off campus at the HQ of ANSYS Corporation in San Jose after 5 PM to 8 PM instead of regular class times
Special Notes to Students in This class:

- First, I would like to congratulate your signing up this course, because FEM is the analytical experience that no mechanical engineer can afford not to have for their successful career.

- The trade-off, however, is that it is NOT an easy course by undergraduate level. So, do NOT expect it to be an easy course.

- There are a number commercial FE codes available in the marketplace. Major companies such as Lockheed-Martins Co. has several such codes available. These commercial codes are easy to follow in analyses (we call them “cookbook” packages. Even technicians can use these code by following the recipes. But it is necessary for you to be an intelligent user as engineers. You cannot be an intelligent user if you do not have sufficient knowledge in the FUNDAMENTAL PRINCIPLE of FEM. This is what this course tries to offer.

- The first part of the course will be on the FUNDAMENTALS of FEM, with predominant math coverage, which may be “boring” to some of you. However, these “fundamentals” will make your learning the applications of FEM in two ME disciplines on heat transfer and stress analysis of solid structures easier, and even enjoyable.

- Despite what have been said above, I will do my best to help you learning this critical subject.